

Operating Instructions RaceCar Tymp





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1 Introduction

Thank you very much for purchasing a quality product from the MAICO family. This automatic Race Car Tympanometer is manufactured to meet all quality and safety requirements, and has been certified with the CE symbol according to Medical Directive 93/42/EEC. Please note: This medical instrument should only be operated by skilled personnel.

In designing the MAICO Race Car Tympanometer we placed particular importance in making it a user-friendly device, meaning its operation is simple and easy to understand. And because all functions are software controlled, upgrading later to new, extended measurement functions will be simple and inexpensive. That means that you have invested in a device that will adjust to your future needs.

This user manual should make it as easy as possible for you to become familiar with the functions of the MAICO Race Car Tympanometer. Please open out the flap of illustrations on the last page. The description of the position (e.g. ⑤) of controls, displays and connections, found again in the text, will make it easier for you to learn how to operate the MAICO Race Car Tympanometer.

If you have problems or have ideas for further improvements, please get in touch with us. Simply call.

Your MAICO-team



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2 Description

2.1 Purpose

The Race Car Tympanometer is an automatic instrument designed for tympanometric screening and diagnostic applications. The instrument performs automatic impedance tests along with multi-frequency, multi-level reflex screening.

Test results are displayed on the front panel LCD screen and may be printed.

2.1.1 PC-Interface:

An USB-interface for data transfer to a connected computer is built in.



The MAICO Race Car Tympanometer produced according to the EN of 60 601-1 „medically electrical devices “. In order to ensure this also with attached computer, the computer must correspond to the EN 60 950-1 or EN 60 601-1. Further more the computer must at least one distance from 1.5 m keep to the patient.

2.1.2 Environmental conditions for the Race Car Tympanometer

The Race Car Tympanometer should be operated in a quiet room.

The test room must be at normal temperature, usually 15° C / 59° F to 35° C / 95° F, and the instrument should be switched on about 10 minutes before the first measurement to guarantee precise measuring results. If the device has been cooled down (e.g. during transport), please wait until it has warmed up to room temperature.

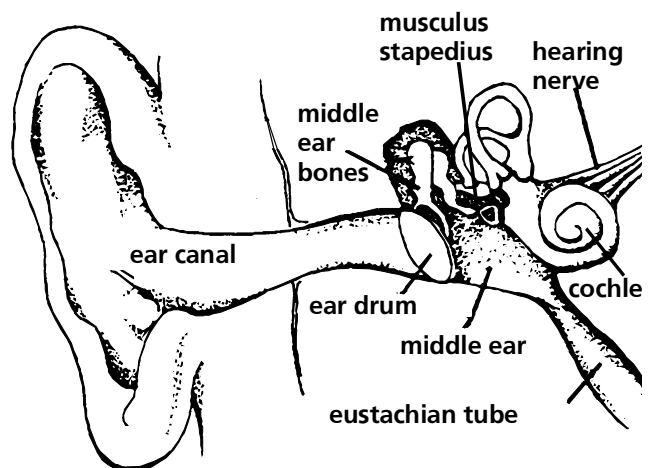


Figure 1 the middle ear

2.2 Tympanometry

Tympanometry is the objective measurement of middle ear mobility (compliance) and pressure within the middle ear system.

During the test, a low-pitched probe tone (226 Hz) is presented

to the ear canal by means of the hand-held probe. This tone is used to measure the change in compliance in the middle ear system while the air



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pressure is varied automatically from a positive value (+200 daPa) to a negative value (-400 daPa max.).

Maximum compliance of the middle ear system occurs when the pressure in the middle ear cavity is equal to the pressure in the external auditory canal. This is the highest peak of the curve as it is recorded on the chart. The position of the peak on the horizontal axis and on the vertical axis of the chart will provide diagnostic information regarding the function of the middle ear system. Examples of normal and abnormal tympanograms can be found in a later section of this manual.

Gradient calculations are reported as the tympanogram width at half of peak compliance expressed in daPa. A "limits" box is available on both the display and printout to aid in diagnosis.

Compliance is measured with respect to an equivalent volume of air, with the scientific quantity milliliter (ml). Air is measured in deca-Pascals (daPa).

NOTE: 1.02 mmH₂O = 1.0 daPa.

2.3 Acoustic Reflex

An acoustic reflex, or contraction of the stapedial muscle, occurs under normal conditions when a sufficiently intense sound is presented to the auditory pathway. This contraction of the muscle causes a stiffening of the ossicular chain which changes the compliance of the middle ear system. As in Tympanometry, a probe tone is used to measure this change in compliance.

When the stimulus presentation and measurement are made in the same ear by means of the probe, this acoustical reflex is referred to as an ipsilateral acoustic reflex. When the stimulus presentation and measurement are made in opposite ears, the reflex is referred to as a contralateral acoustic reflex.

For best results, this reflex measurement is automatically conducted at the air pressure value where the compliance peak occurred during the tympanometric test. Stimulus tones of varying intensities at 500, 1000, 2000 or 4000 Hz are presented as short bursts. If a change in compliance greater than 0.05 ml is detected, a reflex is considered present. Because this is an extremely small compliance change, any movement of the probe



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during the test may produce an artifact (false response). The level at which a reflex occurs is recorded as a number, as PASS/FAIL and in graph form.

If the tympanometric results display any abnormal findings, the results of the acoustic reflex testing may be inconclusive and should be interpreted with care. If a "flat" tympanogram is observed, showing a non-mobile middle ear system, the Race Car Tympanometer will not perform an acoustic reflex test. Theoretically, a compliance peak is necessary to observe a reflex at peak pressure.



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3 Getting started

Your Race Car Tympanometer was carefully inspected and packed for shipping. However, it is good practice to thoroughly inspect the outside of the shipping container for signs of damage. If any damage is noted, please notify the carrier immediately.

3.1 Unpacking

Save all the original packing material and the shipping container so the instrument can be properly packaged if it needs to be returned for service or calibration.

Please check that all accessories listed below are received in good condition. If any accessories are missing or damaged, immediately notify your MAICO Special Instrument Distributor.

Accessories	Part No.
1 Hand-held probe with screening insert	705 150
24-count eartips kit:	705 069
(4) yellow, 7 mm	705 056
(4) green, 9 mm	705 057
(4) white, 11 mm	705 058
(4) yellow, 13 mm	705 059
(4) green, 15 mm	705 060
(4) blue, 18 mm	705 061
Thermal printer paper (1 roll)	705 078
Calibration test cavity	705 167
Mains cable	8 694 400 528
Sticker roll Race Car	861 014

3.2 Preparing the Race Car Tympanometer for use

3.2.1 Connect probe and accessories

Connect the probe cable to socket © on the rear of the instrument. Insert the plug into the socket and protect the connection by fastening the two screws of the connector.



Figure 2
The probe of the
Race Car Tympanometer

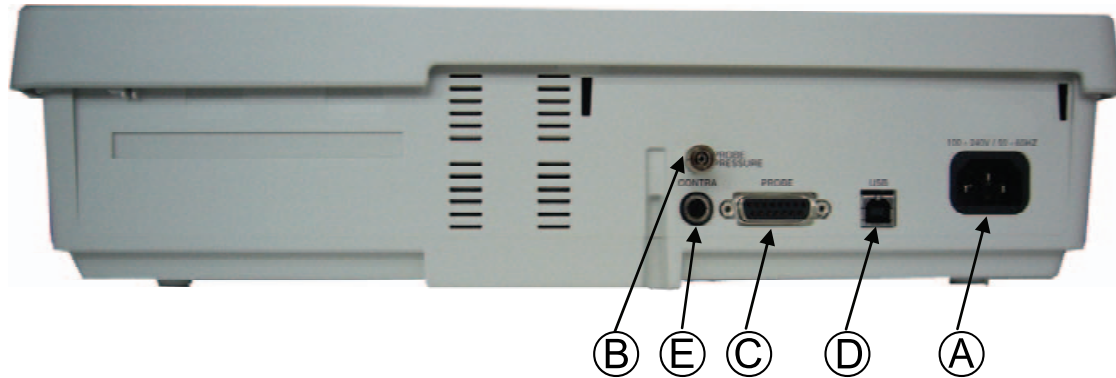


Figure 3 Connectors at the rear of the Race Car Tympanometer

- | | |
|-----------------------------------|---------------------------|
| Ⓐ = mains connection socket | Ⓑ = probe tube connection |
| Ⓒ = probe connection socket | Ⓓ = USB PC-interface |
| Ⓔ = contralateral earphone socket | |

Insert the pressure tube into the socket Ⓑ and press it until it has a safe fit on the socket.

3.3 Connect mains cable and accessories

Put the enclosed mains cable into the power connection socket Ⓐ and its mains plug into a power socket. The instrument is now operational. In case your Race Car Tympanometer is equipped with a contra receiver. Plug the cable in the contra receiver socket Ⓔ.

3.4 Switch the instrument on

Switch the mains switch ⑭ on. The LCD display ⑤ shows for a moment the instrument type and the software version. Then the basic measuring figure appears. The Race Car Tympanometer should be switched on about 10 minutes before the first measurement to guarantee precise measuring results. If the device has been cooled down (e.g. during transport), please wait until it has warmed up to room temperature.

3.5 Getting familiar with the Race Car Tympanometer



Figure 4 Controls of the Race Car Tympanometer

- | | |
|-----------------------------------------------------------------------|----------------------------|
| ① = Print key | ⑨ = Left (cursor control) |
| ② = Right/left ear key | ⑩ = Down (cursor control) |
| ③ = Reflex measurement off/ipsi/contra/
Setting of high probe tone | ⑪ = Right (cursor control) |
| ⑥ = Printer Cover | ⑫ = Up (cursor control) |
| ⑦ = Paper slot | ⑬ = Enter |
| ⑧ = Menu key | ⑭ = Power switch |

The use of the extended functions is described in chapter 10 "Individual Setup of the Race Car Tympanometer".



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3.6 The display of the Race Car Tympanometer

The test result is shown during the measurement on the LCD display. The measurements are saved automatically and can be printed out in a fast and quiet way with the integrated printer.

In figure 5 the initial empty measurement screen is shown. The measurement screen shows actual settings, test results and the graphical display of the tympanogram and reflexes.

The top line shows from left to the right the type of test (in example figure 5 Impedance), the selected test ear left or right and the selected reflex test "ipsi", "contra" or "Tympanogram" if no reflex test is selected.

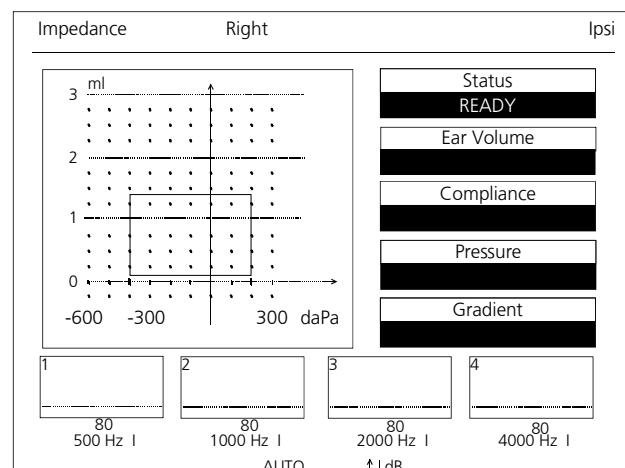


Figure 5
Measurement screen of the Race Car Tympanometer

At the left centre the graph of the tympanogram is shown. At the right five boxes show the status and test values.

The upper box shows the actual status of the instrument:

- **READY** means that the instrument is ready for testing
- **IN EAR** shows that the probe is inserted in the ear
- **TESTING** means that the test is in progress
- **BLOCKED** means that probe is blocked in the ear
- **LEAKING** indicates that the air seal of the ear tip in the ear is not proper

When the test is finished, the boxes below show the volume of the ear canal, the compliance, the pressure at maximum compliance and the gradient of the tympanogram.

The four boxes below the tympanogram, marked 1 to 4, show the graphical reflex curves after the test. Below each box the test level and the test frequency are shown. After the frequency an "I" shows the ipsilateral testing is selected.



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At the bottom line in figure 5 the word "AUTO" and \updownarrow dB Scale is shown. It means that the reflex test level increases automatically until a reflex was found or the maximum level is reached. With the cursor up button ⑫ or down button ⑩ the test level can be changed to a fixed level. The dB values below the boxes change accordingly. It is possible to have fixed levels from 70 dB to 100 dB and AUTO.



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3.7 Calibrate the probe

With the calibration test cavity you adjust your impedance of your tympanometer. Do the same when you change the probe (from screening probe to diagnostic probe and vice versa). The calibration is very easy and takes only 20 seconds.

Press the menu key ⑧ and the main menu (figure 6) appears on the LCD display ⑤. Select the menu option Calibration with the Down button ⑩. Press Enter ⑬ and follow the instructions on the LCD display ⑤, as shown in Figure 7.

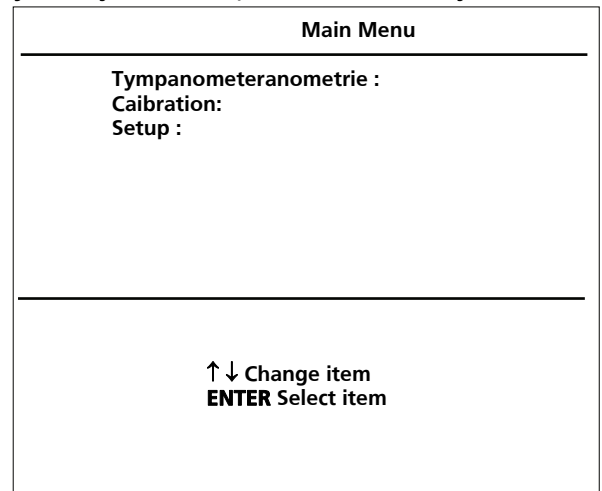


Figure 6
Display Race Car Tympanometer Main Menu

Put the probe tip without ear tip into the hole of the test cavity labeled 0.5 ml and wait. When the text on the display ⑤ changes to the request for the 2 ml calibration put the probe tip in the 2 ml cavity and proceed as described above. After the successful calibration of the 5 ml volume the Race Car Tympanometer switches automatically to the tympanometry mode. The basic menu for the impedance measurement appears again and you are ready for measurements.

If the error information **Cavity calibration out of range** appears during the calibration please control if the opening of the probe tip is clean and try to recalibrate the probe. For more information about cleaning the probe also read Chapter 11.1: Cleaning the probe.

If the error information appears again, the probe or the instrument is probably defect. Inform your service to get immediate help.

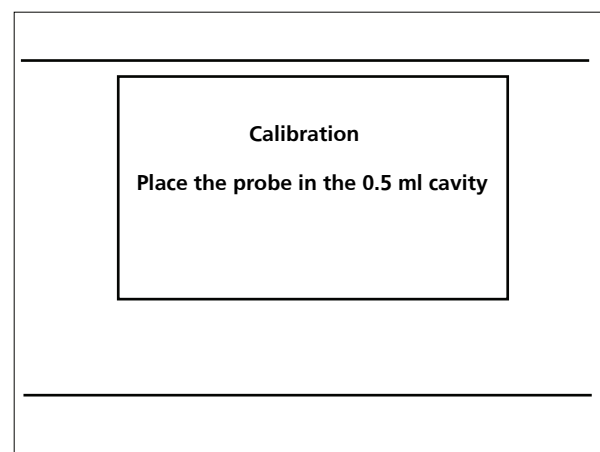


Figure 7
Display Race Car Tympanometer Calibration

3.8 Getting familiar with the probe

The probe of the Race Car Tympanometer is shown in figure 8. The probe head is adjustable in three steps (0°, 60° and 80°). It is adjusted by releasing the fixation screw (Figure 9 ①) at the bottom of the probe, using a coin or a screw driver. Adjust the probe head ② by pulling it into the required position until it rests. To do this hold the probe handle ③ with the other hand. After it is set to the required position fasten the fixation screw ④ again.

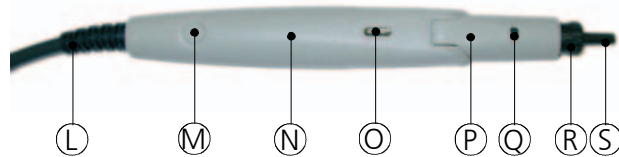


Figure 8 RaceCar probe with standard screening probe tip

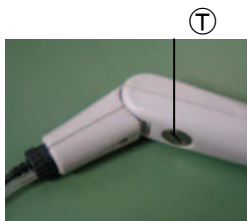


Figure 9

Notice! To avoid damages on the sensitive measuring equipment, only bent the probe toward fixation screw!

Transforming the probe from screening to diagnostic and reverse (optional accessories):

To exchange the probe insert press the release button ⑥ of the probe with a tool or a pen. Remove the screening probe insert.

Note! The squared hole in the probe connection should face in the same direction as the push-button.

Control lights and display

The probe button ⑤ can be used to select the required test ear. The color of the control light ④ changes accordingly to red (right ear) or blue (left ear). If selected in the setup menu pressing the probe button ⑤ during operation pauses also the test.

The color of the control light ④ of the probe indicates in standby the selected ear and in operation the fitting of the probe in the auditory canal:



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A red control light ① indicates that the right ear is selected. The system is ready for measurements. As soon as you have put the probe into the auditory canal the control light ① lights green. Now the test runs off. Do not change the position of the probe any more until the green control light ① is going out indicating the end of the measurement.

A blue control light ② indicates that the left ear is selected. The system is ready for measurements. As soon as you have put the probe into the auditory canal the control light ② lights green. Now the test runs off. Do not change the position of the probe any more until the green control light ② is going out indicating the end of the measurement.

A yellow control light ③ indicates an error. The kind of the error is indicated on the LCD-display ⑤ under status:

LEAKING: The ear tip does not make the auditory canal airtight. Change the position of the probe until the control light ① lights green. If you are not successful use a bigger ear tip.

BLOCKED: Indicates the seal of the probe opening. Change the position of the probe which points maybe at the side of the auditory canal until the control light ① lights green. If you are not successful please check if the probe is blocked with ear wax.

The complete probe insert can be changed by pressing the release button ④ and removing the probe insert.

If the probe tip ⑥ is clogged you can remove it by opening the fixation ring ⑦. After cleaning of the probe tip ⑥ or selection of a new one, the tip must be fixed again by fastening the fixation ring ⑦.

3.9 Choose an appropriate ear tip

Choose an ear tip of the appropriate size from the ear tip set. Put the ear tip tightly on the probe tip. The probe tip should close up with the end of the ear tip. It should not disappear with more than about 1 mm in the ear tip or just out of the ear tip.

By choosing an appropriate ear tip and placing it correctly on the probe you create the basic conditions for measurements without problems and mistakes.



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Now all preparations are concluded and you can start the impedance and reflex measurement. Please read the following chapters.

4 How to create a tympanogram

In the following paragraph we will deal shortly with the principle and the background of the impedance measurement to create a better understanding. If you want to begin the measurements immediately just skip this paragraph and continue reading with **4.3 Preparing the measurements**.

4.1 The basics of the impedance measurement

The impedance measurement serves the diagnosis of the condition of the middle ear and can therefore not be compared directly with other audiometrical tests such as sound or speech audiometry which serve the measurement of the hearing. Furthermore the impedance measurement is an objective measuring method which does not depend on the cooperation of the test person and can therefore not be falsified by him.

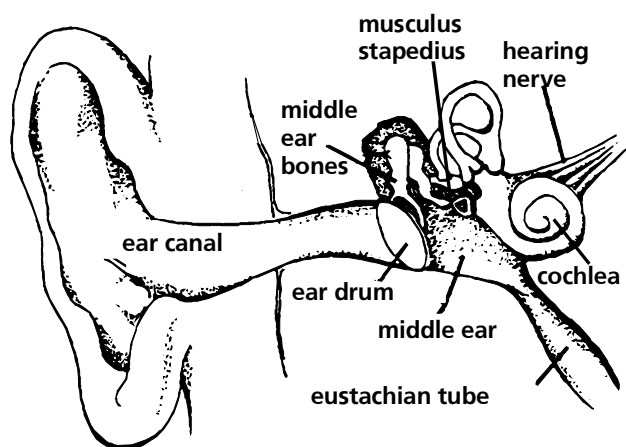


Figure 10 The middle ear

The two most important impedance measuring methods possible with your Race Car Tympanometer are tympanometry and the measurement of the Stapedius reflex which is treated in chapter 6 "How to measure the Stapedius reflex".

The impedance measurement examines the acoustic resistance of the middle ear. If the eardrum is hit by a sound a part is absorbed and sent via the middle ear to the inner ear while the other part is reflected. The stiffer the eardrum is the more sound is reflected and the less sound reaches the inner ear. In the probe of the impedance measuring instrument a small loudspeaker is installed which emits a sound of low frequency via a

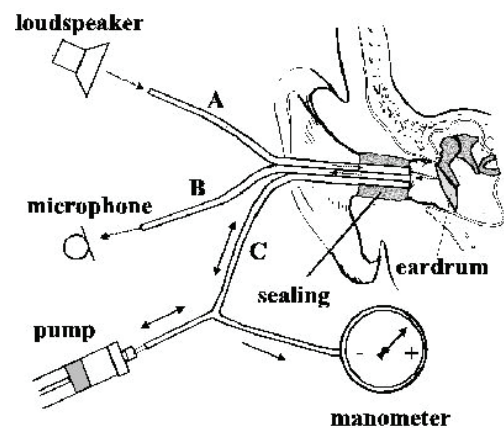


Figure 11 – Principle of impedance measurement



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tube **A** (see Figure 11) into the auditory canal before the eardrum. Another tube **B** is connected to the microphone inside the probe which receives the sound. Together with a third tube **C**, all three are inserted nearly to the eardrum and are made airtight against outside pressure by the ear tip. A manometer and a pump, which can produce both positive and negative pressure, are connected with tube **C**. Less sound is reflected to the microphone when the eardrum is agile (high compliance) and the eardrum transmits the majority of the sound via the middle ear to the inner ear. The highest compliance is normally reached with an air pressure corresponding to the outside pressure.

When performing tympanometry during a measurement a continuous change of over- and under-pressure is performed by the pump of the instrument in the outer auditory canal before the eardrum which is sealed by the ear tip in addition to the measurement with normal pressure. The compliance is measured simultaneously and shown in a diagram, the tympanogram, which illustrates the compliance in ml over the pressure in daPa. In figure 12 the area for normal tympanogram curves is hatched.

Here you can see that the highest compliance is reached with normal pressure. When you create over- or under-pressure the eardrum stiffens - the compliance decreases. So you can draw conclusions on the condition of the middle ear from the form and the values of the tympanogram.

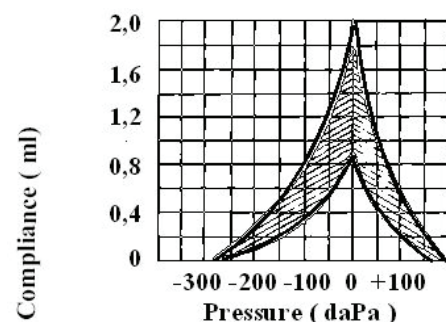


Figure 12 – Tympanogram (normal curve area is hatched)

4.2 Preparing the child for the tympanometry exam

The best way to prepare a child is to pretend that he/she is going to play “a game.” Suggesting that the child is going to “play a game” will assist in reducing the anxiety that may be associated with the test.

Tympanometry can be performed while sitting or standing. The most important consideration is to make the patient as comfortable as possible so he/she can be “still” for just the few seconds necessary to perform the test.

The child should be told that his/her part in the Race Car game is to remain “as still as possible” so the race car on the screen can speed down the track and cross the finish line a “WINNER.” Explain that this is the only way to win the race and avoid getting a “flat tire.”



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4.3 Preparing the measurement

Before you start a new measurement, delete former test results (see also chapter 4.8.) The LCD display shows the empty measurement screen for the right ear and the control light of the probe lights red. If you want to measure the left ear change the side by pressing the **L/R-key** or the probe button. Then the selected test ear shown

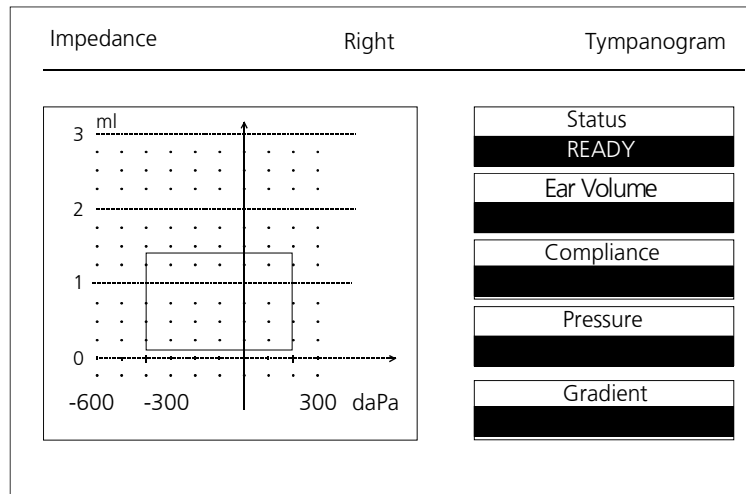


Figure 13 - Measurement screen (only Tympanogram)

in the middle of the top of the LCD display will change from Right to Left and the control light of the probe lights blue. Switch off the reflex measurement by pressing the REFLEX-key. The word Tympanogram must appear at the right top of the display. Control if the auditory canal is free. Choose the right ear tip according to the size of the auditory canal and put it firmly onto the probe tip.

4.3.1. Race Car Modus – Tympanogram Modus

You can switch between car race and tympanogram at any time. To get from race to tympanogram press „MENU“. To get back to the race press „ENTER“.

4.4 Measuring the tympanogram

While the child is distracted by the graphics, place the hand held probe (with proper ear tip) inside the child's ear while gently pulling the earlobe down. Check for excess wax or obstructions. Because children have very small ear canals, this allows the operator to maintain a seal easily.

During the testing, concentrate on holding the probe steady.

BLINKING RED = Unit is in "stand by"

GREEN LIGHT = Test is in progress

SOLID RED (with steady tone) = Probe is blocked

FLASHING RED (with three beeps) = "broken" probe seal



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NOTE: The ear tip does not need to go into the ear canal. It should only seal the canal opening. Attempt to point the end of the ear tip into the canal, toward the eardrum. Depending on the child, a smaller or larger size ear tip may be needed to secure a proper seal.

4.5 Race Car Modus

During the car race on the integrated LCD-screen, the test is performed automatically in the background. If the child does not move or is talking during the test it wins the race.

When the unit is first powered up the screen will show the cheering crowd and the race cars, ready to start the race. (Figure 14)

The cars will start the race when a correct probe seal is achieved and the test is initiated. Race car on track and crossing the finish line will illuminate while the testing is in process.

When the test is completed, "Winner" will illuminate, followed quickly by a cheering crowd and the tympanometer results.

The screen "flat tires" will illuminate when a probe seal is „broken“ during the testing. The child has lost the race. As soon as the child understands the relation between not moving and winning the race testing will be easy.



Figure 14 – Start Screen



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4.6 How to evaluate the tympanometer results

After having carried out a measurement you can see the Tympanometer results on the LCD display.

On the left side of the display you see the tympanogram. The area surrounded by the box is valid for "normal" tympanograms. You can change the area or switch it off. For details see chapter 10 "Individual Setup of the

Race Car Tympanometer". In the middle of the top of the LCD display ⑤ the word **Right** or **Left** indicates the ear chosen at the moment.

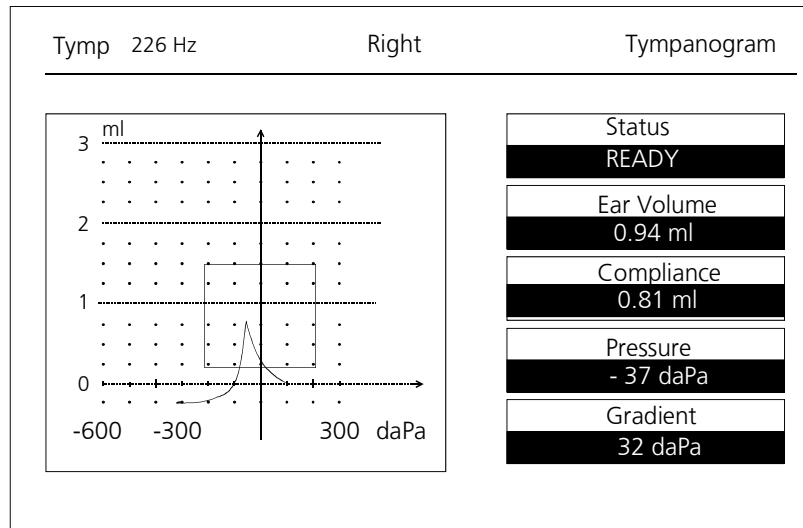


Figure 15 Display of a 226 Hz Tympanogram

Tympanogram at the right top indicates that the reflex measurement has been switched off.

In the boxes at the right the determined measurements are displayed:

Ear Volume indicates the volume of the section of the auditory canal between the ear tip and the eardrum in ml (in the example 0.94 ml).

Compliance indicates the maximum value of the compliance from the Tympanogram in ml (in the example 0.81 ml).

Pressure indicates the pressure with the highest measured Compliance (in the example -37 daPa).

Gradient calculations are reported as the Tympanogram width at half of peak compliance expressed in daPa (in the example 32 daPa).



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4.7 How to print out the test result

After the end of a test you can print out the results for your records by pressing the PRINT button ①. The thermal printer prints out the result in 6 seconds. While the printer is working no key action is possible and the probe is inactive. Figure 16 shows the printout:

Id No.: Here you can put down the patients Social Id number.

Date: Here the actual test date can be stated.

Name: Here you can put down the patients name.

Examiner: State here the reference for the test person.

Remarks: Additional information about the test or patient can be stated here.

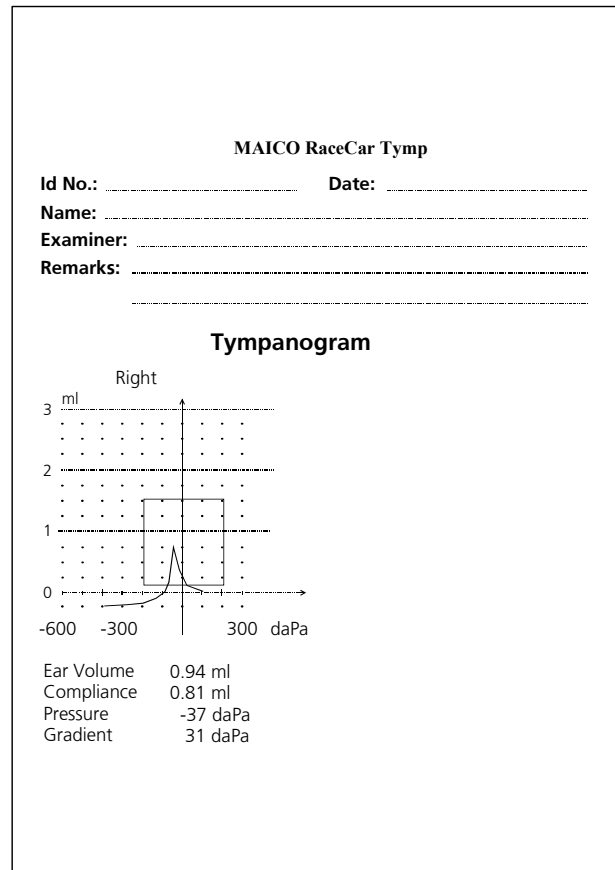


Figure 16 – Printout of Tympanogram

All other values and the tympanogram correspond to those you have seen on the LCD display and which were explained on the previous page under 4.7.

The "intelligent" printer control helps you to save paper. It will only print out what has really been measured. So the printout of the reflex frequencies misses in the example above because only the tympanogram was measured.

If you have saved two tympanograms (for example for both the left and the right ear) both are printed out side by side.

You can produce as many printouts as you want by pressing several times the PRINT button ①.



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4.8 How to delete the test results

By pressing the **L/R**-key ② longer the measurement memory will be deleted. On the LCD-display ⑤ the message "Delete all Data?" occurs. Press the ENTER button ⑬ to delete all patient data. Then the LCD display shows an empty measurement screen.

If you press the MENU button ⑧ you return to the measurement screen without deleting the measurement data.

5 Measuring smaller children with high tone

In addition to the standard 226 Hz probe tone tympanometry, the Race Car Tympanometer has a high frequency probe tone of 1000 Hz that can be selected by the user. A tympanogram recorded using the high probe tone is generally better suited for screening newborns and small children and provides more accurate results for smaller ear canals.

To select high probe tone frequency

When the instrument is switched on, it automatically powers-up in the standard tympanometry mode. In order to choose tympanometry with high probe tone, hold down the Reflex key for two seconds.

The screen for high probe tone tympanometry looks very similar to the normal tympanometry mode, however the following differences will appear on the screen:

The scaling is now measured in mmho.

The pre-selected frequency (1000 Hz) is displayed in the upper left hand side of the screen.

The tympanometry test with high probe tones is performed in the exact same way as a normal tympanometry test.

It is possible to perform normal tympanometry and high probe tone tympanometry in one test session and print the results for comparison. When the first tympanometry curve has been drawn, press the Reflex key for two seconds to switch to high probe tone tympanometry. Now the next curve will be drawn automatically. Press Print and a printout presenting both curves will appear.

Note: It is not possible to perform reflex tests on the basis of a high probe tone tympanogram.

6. How to measure the stapedius reflex

6.1 The basics of the stapedius reflex measurement

While the tympanometry method measures the change of the compliance caused by changing pressure in the outer auditory canal, the stapedius reflex measurement works with a changing compliance caused by contraction of the stapedius muscle in the middle ear. The contraction - called stapedius reflex - causes a decrease in compliance and is caused by loud acoustic stimuli. Regardless whether the acoustic stimulus is

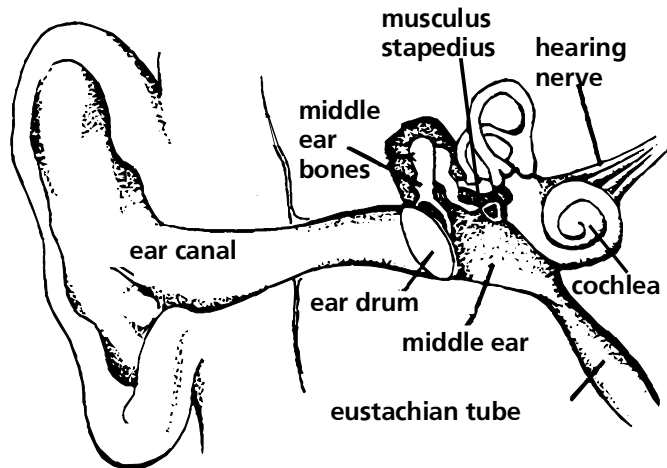


Figure 17 The middle ear

active on the left or on the right or on both sides the stapedius reflex is always binaural, i.e. it occurs in both ears at the same time. The stapedius reflex is caused in ears of adults with normal hearing by sine sounds with sound pressure levels between 70 and 105 dB.

The reflex method measures continuously in one ear, the "probe ear", the compliance with the pressure which caused before the highest compliance. Simultaneously the "stimulus ear" is irritated by the sound which causes the contraction of the stapedius muscle.

The ipsilateral reflex measurement uses the same ear for the probe and the stimulus. The contra-lateral measurement uses different ears for the probe and the stimulus. The acoustic stimulus is offered to the ear opposite to the "probe ear".

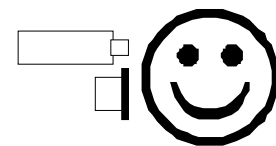


Figure 18 Ipsilateral test

If the offered stimulus causes a reflex the impedance measuring instrument registers a decrease in compliance in the "probe ear" which indicates a stapedius reflex at the actual test frequency and the test level. The test level which was set when the reflex occurred is called reflex threshold and is shown in dBHL (dB hearing loss).

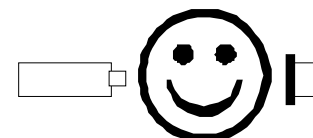


Figure 19 Contra lateral test



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6.2 Training the child

In addition to the general introduction described in chapter 4.2 you should explain to the child that loud test sounds will occur during the reflex measurement. It is very important that he/she does not move the head at all because a reflex can be registered already with a change of compliance of 0.05 ml.

6.3 Preparing the ipsilateral measurement

The LCD display shows the empty tympanogram for the right ear and the control light ⑤ of the probe lights red. If you want to measure the left ear change the side by pressing the **L/R**-key ② or the probe button ⑤. Then the selected test ear, shown in the middle of the top of the LCD display ⑤, will change from **Right** to **Left** and the control light ⑤ of the probe lights blue.

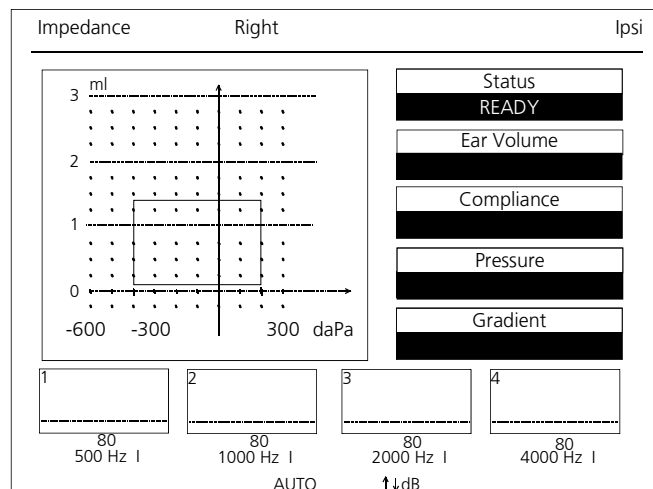


Figure 20 Display Tympanogram + Reflex
(ready for measurement)

Switch the reflex measurement on by pressing the **REFLEX**-key ③. The word **Ipsi** must appear at the right top of the display ⑤. The sound stimuli for the reflex measurement are reproduced by the receiver integrated in the probe.

Set the desired volume level with the Down-key ⑩ respectively the Up-key ⑫. On the LCD display ⑤ below the reflex boxes at the bottom the selected level in dB (in example figure 20, 80 dB) appears. The "I" indicates that an ipsilateral test is selected. You can choose between the fixed levels 70, 75, 80, 85, 90, 95 and 100 dB_{HL} and AUTO with a starting level of 70 or 80 dB_{HL}. If you choose AUTO the Race Car Tympanometer starts with the lowest level 70 dB_{HL} or 80 dB_{HL} and increases the level automatically until a reflex is registered or the maximum value is reached. You can choose your individual starting level and maximum level (**10.3 The Setup menu for Reflex Test**). If you have chosen a fixed level the instrument measures only with this level.

Check if the auditory canal is free. Choose the right ear tip according to the size of the auditory canal and put it firmly onto the probe tip.



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6.4 Doing the ipsilateral measurement

Carry out the measurement as described in chapter 4.4 "Measuring the Tympanogram". The stapedius reflex is measured after the measurement of the Tympanogram. During the measurement of the stapedius reflex the change of the compliance is represented in real time on the LCD display ⑤. When the test is finished the curves for the changes of compliance for 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz are shown in four separate graphs at the bottom of the measurement screen (see Figure 23). Below each curve you see the test level where a stapedius reflex was registered automatically. This is indicated by a "PASS" below the frequency. If no reflex was detected, a "NR" is reported and the maximum level is shown.

You can judge watching the real time graph if you have a "real" stapedius reflex or only disturbance and artifacts. The lower dotted zero-line of a graph indicates the measured compliance without a test sound. All the positive or negative changes of compliance are shown as deviation from the zero-line. If a stapedius reflex occurs the compliance decreases and the curve rises. The box which occurs during the test symbolizes the threshold at which the Race Car Tympanometer accepts a change of compliance as valid stapedius reflex.

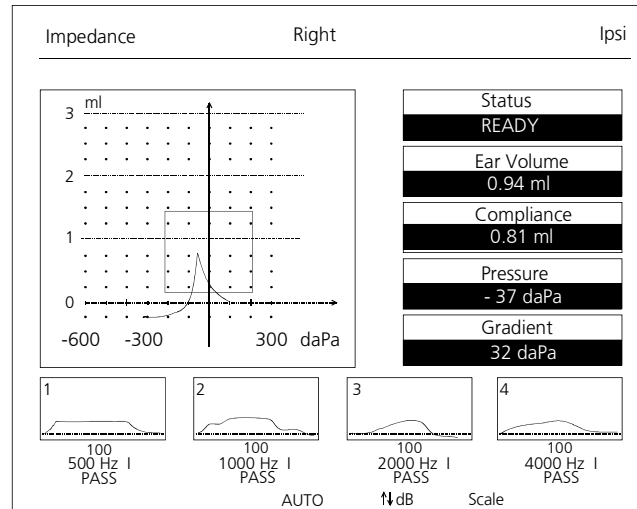


Figure 21 Example of a normal Tympanogram with ipsilateral reflex results



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6.5 Preparing the contralateral measurement

Switch on the contralateral reflex measurement by pressing again the red **REFLEX**-key ③. The word **CONTRA** must appear on the right top of the LCD - display ⑤. Here the highest fixed level is 110 dB_{HL} (with optional TDH 39 contra phone only).

The contra lateral measurement produces more reliable results because the earphone emitting the test signal and the probe measuring the compliance are separated.

Continue now as described previously for the ipsilateral measurement.

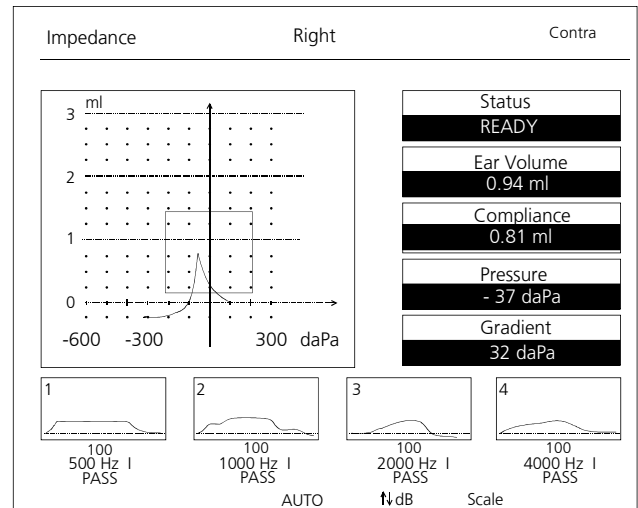


Figure 22 Example of a normal Tympanogram with contra- lateral reflex results

6.6 How to interpret the reflex display

After having carried out a measurement you can read the recorded values on the LCD display.

In addition to the Tympanogram shown on the left side and the values shown on the right, you now see the results of the reflex measurement in the lower part of the display ⑤. In four boxes marked 1 to 4 the stapedius response is shown graphically.

Below each box the test level, the test frequency and the type of the test (I=ipsi, C= contra lateral) are shown. Also the test result is shown as "PASS" or "NR". In the example in Figure 23 for 500 Hz a stapedius reflex was registered at 100 dB_{HL} and for 4 kHz at 100 dB_{HL}. If no reflex

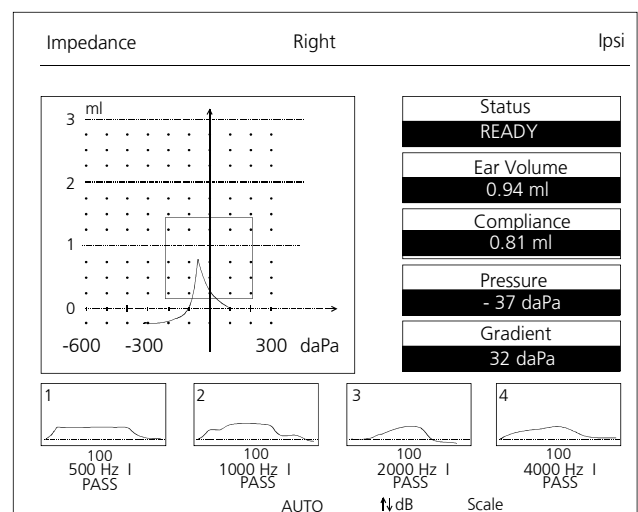


Figure 23 Example of a normal Tympanogram with ipsilateral reflex results



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threshold was registered the information **NR** appears below the frequency.

A correct interpretation of the measuring results can only follow in connection with the Tympanogram, the graphic reflex display and other actual data. But in principle you can say that a stapedius reflex indicates that the patient hears on the "stimulus ear" and that the sound lead on the "probe ear" functions.

6.7 How to print out the test result

After a test you can print out the result for your documents by pressing the PRINTER button ①. The quiet thermal printer prints out the example used in the previous paragraph 6.6 in only 12 seconds. While the printer is working no key action is possible and the probe is inactive.

In addition to the printing text treated in chapter 4.6 the result of the reflex test is printed out:

The level value (dB_{HL}) at which a reflex had been measured appears below the graph.

If no reflex had been registered FAIL is printed on the top of the graph behind the test frequency.

The printout supports you to evaluate the test results correctly.

The graphs of tympanogram and reflex are useful for interpretation: The tympanogram displays the middle ear mobility. The horizontal axis shows the pressure, the vertical axis the compliance.

The reflex is displayed in four charts. Here the x-axis stands for time, the y-axis shows the changes of compliance.

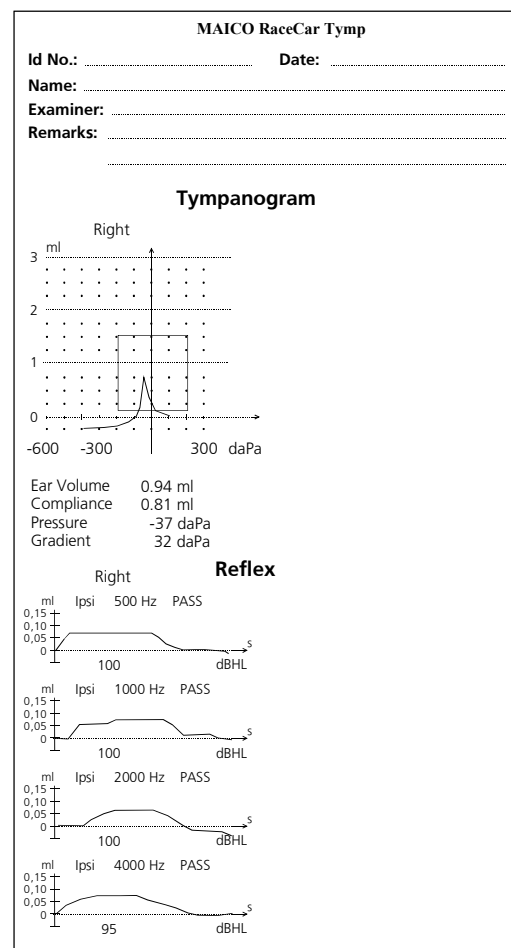


Figure 24 - Printout of a Tympanogram with ipsilateral reflex tests



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7 Interpreting Test Results

7.1 Understanding the printout

The printout contains the following information: Ear volume, Compliance, Pressure, Gradient, Reflex Test Results (PASS, NR) and IPSI, CONTRA or Tympanogram (depending on the test you have done). This information provide the data you need to interpret the test results.

A graph of the tympanogram is provided (Figure 25) to assist you in visual interpretation of the test. This graph is a representation of the relative mobility of the middle ear system. The horizontal axis shows the changes in air pressure and the resulting mobility of the system. The compliance is recorded on the vertical axis. This mobility is expressed as a change in the volume of the ear canal in ml.

The reflex is shown in up to four graphics with time on the horizontal axis and the change of the compliance on the vertical axis.

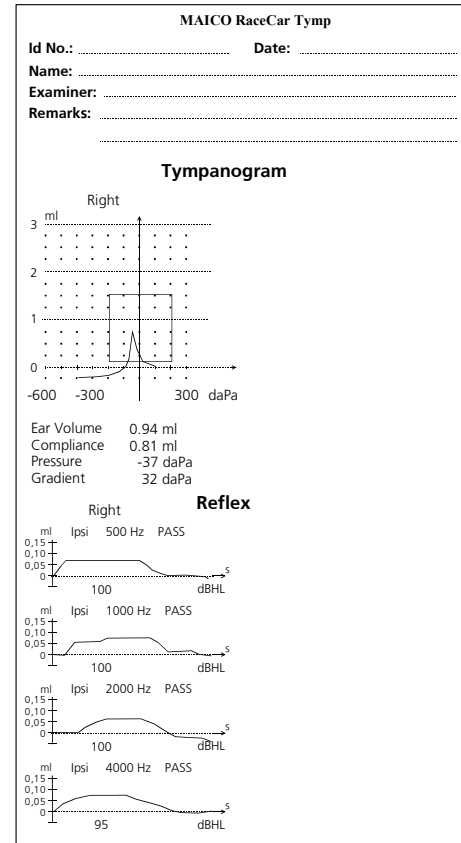


Figure 25 - Printout of a Tympanogram with ipsilateral reflex tests

7.2 Interpreting the tympanometric test result

As a general rule, values for ear canal volume should be between 0.2 and 2.0 ml (children and adults). A variance will be seen within this range depending on the age and ear structure of the person. For example, a 2.0 ml or larger reading in a small child could indicate a perforation in the tympanic membrane, while it may be a normal reading in an adult. You will become more familiar with the normal ranges when you use the instrument.



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The normal range for compliance is 0.2 ml to approximately 1.8 ml. A compliance peak within the range indicates normal mobility of the middle ear system. A peak found outside of these limits may be indicative for one of several pathologies.

Middle ear pressure should be equivalent to ambient air pressure (0 daPa on an air pressure scale). Minor shifts of the peak compliance to the negative may occur with congestion and are rarely to the positive side. Establish criteria for abnormal negative pressure when you become more familiar with using the equipment. It is generally accepted that negative pressure of greater than -150 daPa indicates a referral for medical evaluation.

7.3 Abnormal values

It is the purpose of this section to provide samples of tympanograms which reflect abnormal states of the middle ear mechanism. It is not the intention of this section to provide you with a complete guide to interpreting results. Complete information regarding pathologies and abnormal impedance testing can be found in the literature referenced.

A perforation in the tympanic membrane will cause a high ear canal volume measurement because the instrument will measure the volume of the entire middle ear space. The Race Car Tympanometer may refuse to run the test, with the probe indicating a volume out of tolerance by illuminating the red light, or a flat tympanogram will be recorded since no movement will occur with a change in air pressure. Without a peak compliance of at least 0.1 ml, the reflex test will not initiate.

An extremely flaccid tympanic membrane or an ossicular chain discontinuity will yield very high peak compliance in the presence of normal middle ear pressure. Ear canal volume will be normal and the reflex will be absent.

A fixation of the ossicular chain, as in otosclerosis, will produce a Tympanogram with very low compliance in the presence of normal middle ear air pressure. Ear canal volume is normal and the reflex is absent.

Middle ear fluid such as serious otitis media will yield a very flat tympanogram with no definite peak and negative air pressure. A resolving case or beginning case may produce a reduced peak in the presence of severe negative middle ear pressure. The ear canal volume is normal and the reflex is either absent or at an elevated level.



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Eustachian tube dysfunction in the absence of fluid will show a normal compliance curve, but it will be displayed to the negative side of the tympanogram. Ear canal volume will be normal and the reflex may be present, depending on the degree of involvement.

8 How to test children

The practice of the impedance measurement is difficult especially with small children. You could have problems with the child being restless or afraid of the examination or reacting sensitively to the change of pressure and the loud test sound but also with different conditions of the eardrum and the middle ear which do not appear in ears of adults.

During the measurement the minimum compliance must come to 0.08 ml, if it is less a straight line runs over the zero line.

It is difficult to reach a probe seal with restless children. If the child yawns or cries it is impossible for the instrument to create a stable pressure in the outer auditory canal. In addition speaking causes stapedius muscle reflexes which lead to a permanent change of the compliance of the eardrum.

So the child should be made familiar with the surroundings and the ear being touched by the probe in order to carry out a successful impedance measurement. This could be done by getting in touch with the child and by touching the ear in a playing way with the probe. If you can touch the ear without problems the child will normally accept the probe being inserted.

If the child has accepted the surroundings and the touch of the ear it is important to distract the child's mind from the measurement. Here you can succeed in diverting the child by many different methods. Your phantasy is nearly unlimited, you just have to avoid loud sound.

In case you measure very small children and have to calm them with e.g. a dummy or a teal feeding bottle the result might be slightly falsified, maybe by a slightly irregular line of the Tympanogram.



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9 Recommended literature

Auditory Disorders: A Manual for Clinical Evaluation
Jerger, Susan, and James Jerger
Boston: College Hill Press, 1981

Handbook of Clinical Audiology
Katz, Jack
Baltimore: William & Wilkins, 1994

Roeser's Audiology Desk Reference
Roeser, Ross J.
New York / Stuttgart: Thieme, 1996

Auditory Diagnosis Silam, Shlomo and Carol A. Silvermann
San Diego / London: Singular Publishing
Group, 1997



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10 Individual setup of the Race Car Tympanometer

While getting familiar with the Race Car Tympanometer in the previous chapters you had the chance to find out how easy the instrument is to control. You can carry out all normal measurements and print them out, too.

In addition the Race Car Tympanometer offers many "hidden" chances for the experienced user to adapt the instrument to his individual demands.

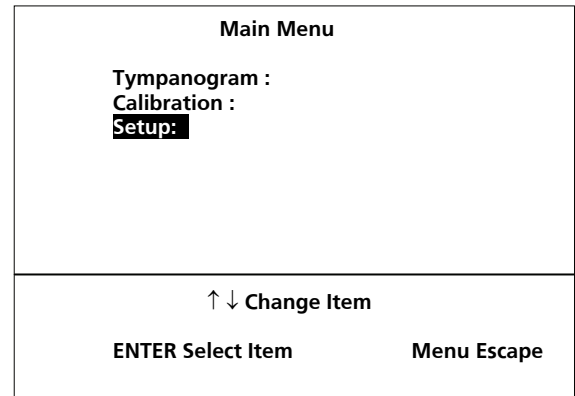


Figure 26
Main Menu (Setup activated)

In the following all the setup options are treated precisely. The settings shown in the figures are the standard settings. If you have altered a value by accident you just have to return to the standard setting shown here and the instrument will work as before.

By pressing the menu key ⑧ you can return from every sub-menu to the main menu and after all to the Tympanometry mode.

You can change the menu options with the cursor keys: Up ⑫, Left ⑨, Down ⑩ and Right ⑪. The menu option actually selected is marked inverse on the LCD display ⑤ (SETUP in the example Figure 26). You select the chosen menu option by pressing Enter ⑬.

10.1 The setup menu

Select the menu option SETUP as illustrated in Figure 27 and the main setup menu will appear on the LCD display ⑤. You can make different settings for the measurement of the Tympanogram and the stapedius reflex, for instrument setup (for example the contrast of the LCD display⑤). All your settings are saved permanently until you will change them again. The settings also survive when the instrument is switched off.

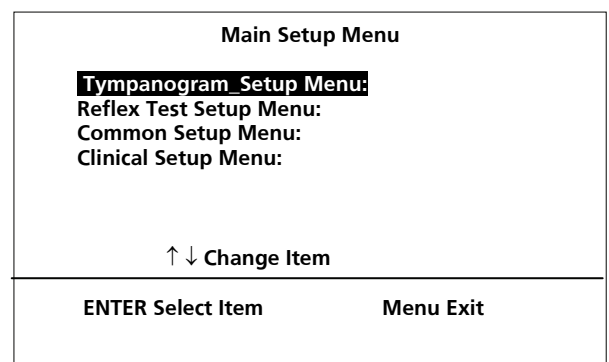


Figure 27
Main Setup Menu (Setup activated)



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10.2 Tympanogram Setup Menu

Select the menu option "Tympanogram Setup Menu": As illustrated in Figure 28 and the Tympanogram setup menu will appear on the LCD display ⑤.

You change the menu options with the cursor keys DOWN ⑩ respectively UP ⑫. You can change the invers displayed item with the cursor keys LEFT ⑨ respectively RIGHT ⑪. The following settings are possible:

Tympanogram Setup Menu	
Pump Speed:	Automatic
Display limits:	ON
Press. Limit hi.:	150 daPa
Press. Limit Lo.:	-400 daPa
Comp Limit hi.:	1.5 ml
Comp. Limit lo.:	0.1 daPa
Seal sensitivity:	Medium
↑↓ Change item Change item setting MENU Exit	

Figure 28
Tympanogram Setup Menu

Pump speed:

With this option you can set the measurement speed. With "Automatic" the pump speed adjusts automatically to the test conditions. It is possible to choose also Minimum, Medium or Maximum. Of course a lower pump speed creates a higher precision of the measurement but needs more test time.

Display limits:

With ON you switch on the "field for normal curves" surrounded by a broken line in the tympanogram. With OFF you switch it off.

Press. Limit hi:

With this option you can set the right limit of the box for normal tympanograms to a value between 0 daPa and +200 daPa in steps of 25 daPa.

Press. Limit lo:

With this option you can set the left limit of the box for normal tympanograms to a value between -400 daPa and -25 daPa in steps of 25 daPa.

Comp. limit hi:

With this option you can set the upper limit of the box for normal tympanograms to a value between 0.1 ml and 3 ml in steps of 0.1 ml.



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Comp. limit lo:

With this option you can set the lower limit of the box for normal tympanograms to a value between 0.1 ml and 1ml in steps of 0.1 ml.

Seal sensitivity:

Medium: Quicker seal detection and less sensitive than the above selection.

Minimum: This gives reproducible results. Requires quiet probe handling.

Maximum: Quick seal detection.

Robust: Very quick seal detection.

To leave the Tympanometry Setup Menu presses the MENU button.



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10.3 Setup Menu for Reflex Test

Select the menu option "Reflex Test Setup Menu" from the main setup menu as described before for the "Tympanometry setup menu" and the reflex setup menu will appear on the LCD display ⑤.

The reflex setup menu offers the following options:

Auto start dB:

With this option you can choose the acoustic pressure level the Race Car Tympanometer starts the reflex level measurement with if the automatic identification of the reflex threshold is switched on. You can choose the acoustic pressure levels from 70 dB_{HL} till 100 dB_{HL} in steps of 5 dB.

Auto maximum dB:

With this option you can choose the maximal acoustic pressure level the Race Car Tympanometer uses if the automatic identification of the reflex threshold is switched on. You can choose the maximum acoustic pressure levels from 70 dB_{HL} till 110 dB_{HL} in steps of 5 dB.

Reflex sensitivity:

With this option you select the sensitivity of the stapedius reflex detection. With the setting "Sensitive" small changes of the compliance will achieve PASS as test results. With the setting "Robust" a larger compliance change is needed to detect a PASS. The setting "Normal" is the default setting.

Print graphic:

With this option you can switch ON and OFF the printout of the graphic reflex display for documentation.

Reflex PASS/NR

The automatic reflex PASS/NR analysis you can switch ON and OFF.

Reflex Test Setup Menu	
Auto.start dB:	80
Auto maximum dB:	110
Reflex Sensitivity:	Sensitive
Print graphic:	OFF
Reflex PASS/NR	OFF
500 Hz:	ON
1000 Hz:	ON
2000 Hz:	ON
4000 Hz:	ON

↑↓ Change item	
Change item setting	MENU Exit

Figure 29
Race Car Tympanometer Reflex setup
Menu



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500 Hz:

With this option you can switch ON and OFF the stapedius reflex test for 500 Hz.

1000 Hz:

With this option you can switch ON and OFF the stapedius reflex test for 1000 Hz.

2000 Hz:

With this option you can switch ON and OFF the stapedius reflex test for 2000 Hz.

4000 Hz:

With this option you can switch ON and OFF the stapedius reflex test for 4000 Hz.

10.4 The Common Setup Menu

Select the menu option "Common Setup Menu" from the main setup menu as described before and the common setup menu will appear on the LCD display ⑤.

The common setup menu offers the following options:

Power-up:

With this option you can choose the test mode of the Race Car Tympanometer after switching on. With the setting Tympanometer only Tympanometry is tested after power-up.

Choose "Tympanometer and Reflex" tympanometry and reflex are tested after power-up.

High Probe Tone:

With this option you can choose the test mode OFF and ON. If it is on, you can measure with 1000 Hz.

Common Setup Menu_	
Power-up:	: Tymp and Reflex
Communication	: USB
Remote Switch	: L/R
Subject Data Printout	: ON
Clinic Data Printout	: ON
Print After Test	: OFF
RaceCar	: ON
Language	: English
Display adjust	:
↑↓ Change item	
Change Item setting	MENU Exit

Figure 30
Race Car Tympanometer common Setup Menu



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Communication:

This is only the reference to the USB interface.

Remote Switch:

With this option you can change the function of the probe button \textcircled{M} . You can choose between:

L/R: test ear can be selected with the probe button \textcircled{M}

Pause: test can be paused and restarted with the probe button \textcircled{M}

L/R or Pause: Test ear can be selected and the test can be paused and restarted with the probe button \textcircled{M} .

Subject Data Printout:

With this option you can switch ON and OFF the printout of the headline which allows you to enter the data of the patient.

Clinic Data Printout:

If you entered your clinic data the printout of the entered data can be switched ON and OFF with this option.

Print after test:

With this option you enable an automatic printout after you finished a test by setting it ON. With the setting OFF the printout will be only done after you press the PRINT button $\textcircled{1}$.

Race Car:

Race Car Animation (ON) or Tympanogram

Language:

You can choose between the languages German "Deutsch", French "Francais", English and Spanish "Espanol" for the text on the LCD display and the printout. After selection all the texts appear in the chosen language.

Display adjust:

The contrast of the LCD-display $\textcircled{5}$ can be changed with this option.

10.5 Insert your personal printout data

Select the menu option Clinic Setup Menu from the main setup menu to enter all required data of your clinic. These data will be printed out later together with the test result and the patient data. This screen is self explaining.



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11 Care and maintenance of the instrument

Disconnect the power plug before cleaning!

To clean the instrument, probe, contralateral earphone and other accessories use a soft cloth dampened with a little warm soapy water or washing-up liquid; no alcohol or spirits should be used.

During cleaning, please ensure that no liquid runs into the switches, level control or probe openings.

Cleaning of Ear Tips

We recommend using a new ear tip for each patient. If the clinician rinses the ear tips they should be subjected to standard disinfection procedure between patients. This includes physically cleaning the ear tip and use of a recognized disinfectant. Individual manufacturer's instruction should be followed for use of this disinfecting agent to provide an appropriated level of cleanliness.

11.1 Cleaning of probe tip

In order to secure correct impedance measurements it is important to make sure that the probe system is kept clean at all times. Therefore please follow the below illustrated instruction on how to remove e.g. cerumen from the small acoustic and air pressure channels of the probe tip.

For the Race Car Tympanometer two different probe systems exist; the Screening Probe System and the Diagnostic Probe System.

The two different probe systems can be seen in the below picture:

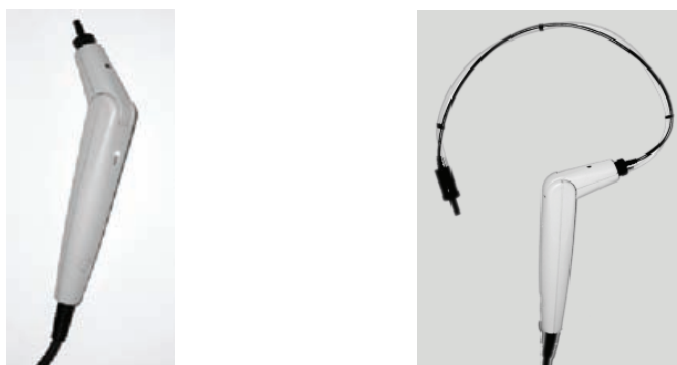


Figure 31 - Screening and Diagnostic Probe System



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To clean the small acoustic and air pressure channels of the probe tip unscrew the small ribbed plastic nut that holds the probe tip:



Figure 32

After unscrewing the small ribbed plastic nut it is possible to detach the small probe tip with the small acoustic and air pressure channels from the transducer house:

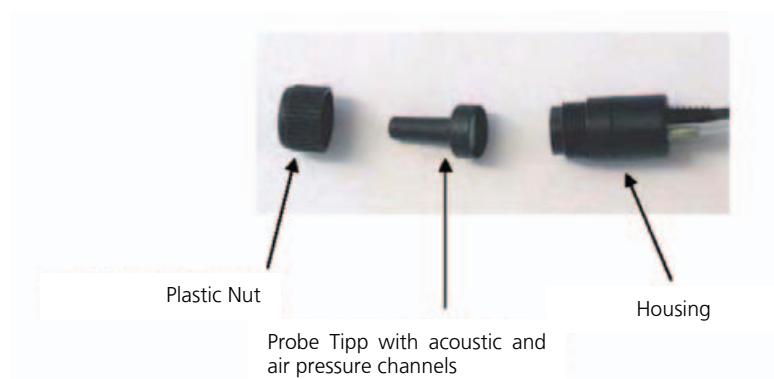


Figure 33

The cleaning of the acoustic and air pressure channels of the probe tip must be performed by means of the cleaning wire (nylon wire) which can be found in the Ear tips Assortment provided with the Race Car Tympanometer.



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When cleaning the acoustic and air pressure channels of the probe tip the cleaning wire must be inserted from the back of the probe tip according to Figure 34:



Figure 34 Transparent Sealing

Besides cleaning the holes ensure also a proper surface cleaning of the transparent sealing.

After cleaning all the acoustic and air pressure channels of the probe tip it can be reassembled. Make sure that the Probe Tip with the transparent sealing is connected correctly onto the Transducer Housing – a small flange will ensure correct positioning - before the plastic nut is gently tightened.



Figure 35



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12 How to change the printer paper

Open the printer at the right side of the housing by pulling up the printer cover ⑥ using its finger mould in front.

Remove the printer cover ⑥.

Remove the empty paper roll.

Place the new paper roll in the paper compartment in such a way that the paper ascends from the lower part of the paper roll.

Pull the blue lever, which is located on the right front of the printer, into its forward position.

The paper must roll from the bottom because it is coated on one side only.

If it is inserted wrongly, no printout is visible!

Gently insert the paper end between the rubber roll and the black plastic part at the rear of the printer.

Transport the printer paper until it appears from the upper part of the rubber roll. Pull then the paper end app. 10 to 15 cm.

Push the blue lever into its backward position.

Guide the paper end through the paper slot ⑦ of the printer cover ⑥.

Close the printer cover ⑥ by putting the two guide rails at the end of the printer cover ⑥ into the appropriate slot of the paper compartment of the housing of Race Car Tympanometer. Press the front of the printer cover ⑥ down until it fastens.

The instrument is now ready to print.



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13 Warranty, Maintenance and Service

The Race Car Tympanometer is guaranteed for 1 year. This warranty is extended to the original purchaser of the instrument by MAICO through the Distributor from whom it was purchased and covers defects in material and workmanship for a period of one year from date of delivery of the instrument to the original purchaser.

The Tympanometer may be repaired only by your dealer or by a service centre recommended by your dealer. We urgently advise you against attempting to rectify any faults yourself or commissioning non-experts to do so.

In the event of repair during the guarantee period, please enclose evidence of purchase with the instrument.

In order to ensure that your instrument works properly the Tympanometer should be checked and calibrated at least once a year. This check has to be carried out by your dealer.

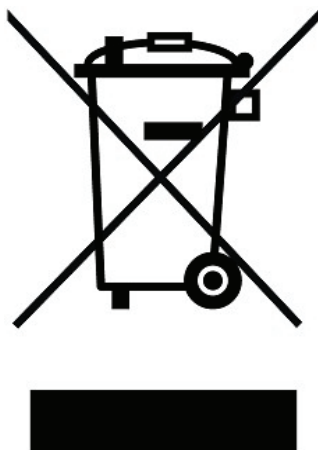
When returning the instrument for repairs it is essential to also send the probe and all other accessories.

Send the device to your dealer or to a service centre authorized by your dealer.

Please also include a detailed description of the faults.

In order to prevent damage in transit, please use the original packing if possible when returning the instrument.

NOTE:



Within the European Union it is illegal to dispose electric and electronic waste as unsorted municipal waste. According to this, all MAICO products sold after August 13, 2005, are marked with a crossed-out wheeled bin. Within the limits of Article (9) of DIRECTIVE 2002/96/EC on waste of electrical and electronic equipment (WEEE), MAICO has changed their sales policy. To avoid additional distribution costs we assign the responsibility for the proper collection and treatment according to legal regulations to our customers.

14 Safety Regulations

14.1 Electrical safety:



The Race Car Tympanometer is constructed to comply with protection class I, Type BF of the international standard IEC 601-1 (EN 60601-1).

Protection from an electric shock is ensured even without the system earth connection.

The instruments are not intended for operation in areas with an explosion hazard.

14.2 Measuring security:

To guarantee that the Tympanometer works properly, the instrument has to be checked and calibrated at least once a year.

The service and calibration must be performed by an authorized service centre. In accordance with the regulations of the EU medical directive we will drop our liability if these checks are not done.

The use of non-calibrated Tympanometers is not allowed.

14.3 Device control:

The user of the instrument should perform a subjective instrument check once a week. This check can be done following the list for subjective instrument check (see next page). For your own security, you should copy the enclosed list, fill it in once a week and store it in your files.

14.4 Operation:

Only skilled personnel (Audiologists, ENT professionals or other with equivalent knowledge) should operate the instrument.



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15 Checklist for subjective device control

According to the manufacturer requirement the user should control the instrument once a week to find errors immediately and to avoid wrong test results. He should test Tympanogram and Reflex with an otologic normal person and compare the results with earlier measurements. The printout should be filed together with the subjective test protocol to the documents of the instrument. The test person should be healthy (no otitis etc.) and should by not be exposed to loud noise at least 12 hours.

Instrument type:

Serial-No.:

Test person:

Connectors and cables OK?
Instrument and probe? OK?
Is the green light of the probe blinking?
Are Probe tip and ear tip clean?
Are all controls easy to use?
Are the test signals clear and non-distorted?

If significant differences or damages are found please inform the service.

Tested by:

Date:



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16 Technical Data and Accessories



The Impedance meter Race Car Tympanometer is an active, diagnostic medical product according to the class IIa of the EU medical directive 93/42/EEC.

Impedance measurement:

Type: Class 2 acc. to IEC 645-5 (EN 60645-5)

Tympanometer:

Test frequency: 226 Hz \pm 1 %
Test level: 85 dB_{SPL} in 2 cm³
High frequency: 1000 Hz \pm 1 %
Test level: 83 dB_{SPL} in 2 cm³
Pressure range: +200 to -400 daPa
Volume range: 0.1 to 6.0 ml
Accuracy: \pm 5 % or \pm 10 daPa
Compliance range: 0.1 to 6.0 ml

Reflex measurement:

Test frequencies: 500 Hz, 1 kHz, 2 kHz, 4 kHz \pm 2 %
Test method: ipsilateral, contralateral (option)
Intensities ipsi: 70 dB_{HL} ... 100 dB_{HL}
Intensities contra: 70 dB_{HL} ... 110 dB_{HL} (with TDH 39 contra phone)
Attack/release time: typical 10 ms
Pressure at test: Pressure at max. compliance

General:

Memory: Storage of test results for both ears
Probe: Probe with screening insert
LCD-display: Race Car animation, graphical display of Tympanograms and reflex curves, numeric display of max. compliance, pressure at max. compliance, canal volume, gradient and reflex thresholds

Printer: Thermal printer, paper roll width 110 mm
Print time: 4 s (one Tympanogram) to 12 s (Tympanogram and Reflex for both ears)
Power supply: Mains 100 ... 240 V ~, 50/60 Hz
Power consumption: app. 25 VA

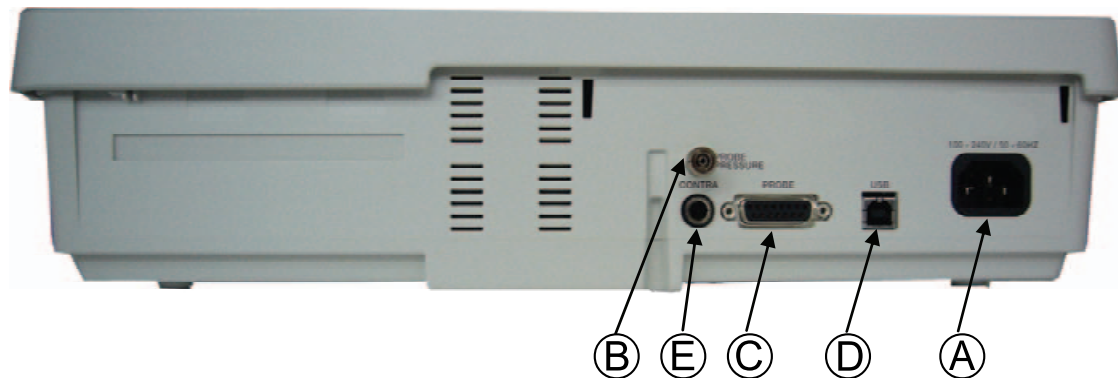


Figure 36 Connectors on the rear

Connection plugs:	Connection	Specification
Ⓐ Mains connection socket	left/right=power	100...240 V~ 50 Hz
Ⓑ Probe tube connection		
Ⓒ Probe connection socket		
Ⓓ PC-interface		USB
Ⓔ Contra receiver socket	sleeve=GND, tip=out	ZA=10 Ω , UA=8 V _{eff}

Warm up time: less than 10 min after power on

Environment

Conditions:

- + 15 ... + 35 C / + 59 ... + 95 F (operation)
- + 5 ... + 50 C / + 41 ... + 122 F (storage)
- Maximum humidity 90 % (storage and operation)

Dimensions: W x D x H: 39 x 29 x 11 cm

Weight: app. 2.6 kg



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Standard accessories:

- 1 hand-held probe
- 1 mains cable
- 1 set of ear tips
- 1 calibration cavity (cavities 5ml, 2ml, 0,5ml) with probe holder
- 1 printer paper roll (for app. 350 printouts)
- 1 sticker roll "Race Car"

Optional accessories:

- | | |
|-------------------------|--------------------|
| TDH 39 contra phone | Part No. 46 82 |
| Carrying case | Part No. 70 50 14 |
| Soft side carrying case | Part No. 1035-3002 |

Consumables:

- | | |
|---------------------------------------|-------------------|
| 1 roll printer paper | Part No. 70 50 78 |
| 1 set of 10 Ear tips yellow (7.4 mm) | Part No. 70 50 56 |
| 1 set of 10 Ear tips green (9 mm) | Part No. 70 50 57 |
| 1 set of 10 Ear tips white (11 mm) | Part No. 70 50 58 |
| 1 set of 10 Ear tips yellow (12.5 mm) | Part No. 70 50 59 |
| 1 set of 10 Ear tips green (15 mm) | Part No. 70 50 60 |
| 1 set of 10 Ear tips blue (18 mm) | Part No. 70 50 61 |



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Specifications are subject to change.



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